High School - Earth and Space Science

Grade	Big Idea	Essential Questions	Concepts	Competencies	Vocabulary	2002 Standards	SAS Standards	Assessment Anchor Eligible Content
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	The Milky Way Galaxy consists of more than two hundred billion stars, the sun being one of them, and is one of hundreds of billions of galaxies in the known universe.	Use models to describe the sun's place in space in relation to the Milky Way Galaxy and the distribution of galaxy clusters in the universe.	Clusters Galaxy Model Star Universe	3.4.10.D	3.3.10.B1	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	Models of the formation and structure of the universe have changed over time as technologies have become more advanced and the accuracy of our data has increased.	Compare time periods in history, the technology available at that time and the resulting model of the organization of our solar system. (e.g. – Early Greeks used purely observational data resulting in a geocentric model).	Geocentric Heliocentric Model Planet Theory	3.1.12.E	3.4.10.B 3.4.10.D3	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	The Milky Way Galaxy consists of more than two hundred billion stars, the sun being one of them, and is one of hundreds of billions of galaxies in the known universe.	Use data about the expansion, scale and age of the universe to explain the Big Bang theory as a model for the origin of the Universe.	Clusters Galaxy Light year Model Theory	3.4.10.D	3.3.10.B1 3.3.12.B2	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	There are multiple sources of evidence for the Big Bang theory including the measurement of red shift, the amount of hydrogen and helium in the universe, and the cosmic microwave background radiation that fills the universe.	Construct explanations based on observable astronomical data as empirical evidence for the Big Bang theory.	Blue shift Cosmic microwave background radiation Electromagnetic spectrum Non-solar gases Red shift Stellar spectra	3.4.10.D	3.3.10.B1 3.3.12.B2	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which	What is the universe and what is Earth's place in it?	The compositions and masses of stars determine their life cycle.	Compare and contrast the life cycles of stars of different masses and compositions, including our sun.	Black hole Dwarf HR diagram Main sequence Nebula	3.4.10.D	3.3.12.B1	

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	develops according to accepted physical processes and laws.				Neutron star Nova Protostar Red giant Supernova			
9-12	The universe is composed of a variety of different objects, which are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	The compositions and masses of stars determine their life cycle.	Develop a model of how the competing forces of gravity and thermal expansion effect a star's density throughout its life cycle.	Density Gravity Thermal expansion	3.4.10.D 3.4.12.D	3.3.12.B1	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	The brightness and magnitude of a star are determined by mass, temperature and distance from the observer.	Use observational data to construct an explanation of a star's apparent (relative) magnitude based on its distance from the observer and its mass.	Absolute magnitude Apparent (relative) magnitude	3.4.10.D 3.4.12.D	3.3.12.B1	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	Nuclear fusion within stars produces all atomic nuclei lighter than and including iron. Heavier elements are produced and distributed through supernovae.	Describe the mechanism by which heavier and heavier elements are produced within a star's core throughout its life cycle.	Elements Nuclear fusion Nuclei Supernova	3.4.10.D	3.3.12.B1	
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to	What is the universe and what is Earth's place in it?	The study of a star's spectra is used to identify compositional elements of a star.	Use observational data to describe the composition of stars.	Elements Spectra	3.4.10.D	3.3.10.B2, 3.3.12.B1	

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	accepted physical processes and laws.							
9-12	The universe is composed of a variety of different objects that are organized into systems each of which develops according to accepted physical processes and laws.	What is the universe and what is Earth's place in it?	Kepler's laws describe the motions of orbiting objects, including their elliptical paths around the Sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	Use mathematical and computational representations of human-made and solar system objects in order to describe their motions and predict their trajectories and/or collisions.	Elliptical Kepler's laws Satellite Trajectory	3.4.12.B	3.3.10.B1, 3.3.12.A1	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Radioactive dating to can be used to determine the ages of rocks and other materials from the isotope ratios that are present. These data can be used to help determine the geologic time scale.	Analyze actual or simulated isotope ratios within earth materials to make valid and reliable scientific claims about the planet's age; the ages of earth events and rocks; and the overall time scale of earth's history. (Consider the incomplete nature of the Earth's rock record when analyzing and interpreting the events of Earth's distant past.)	Elements Geologic time scale Half-life Isotope Radioactive (radiometric) dating	3.5.12.A	3.3.12.A1 3.3.10.A1 3.3.12.A3	
	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Plate tectonics is the unifying theory that explains the geologic movements of the Earth.	Develop a three dimensional model to illustrate how Earth's internal and surface processes operate to form continental and ocean floor features.	Asthenosphere Conduction Convection Convergence Crust Density Earthquake Erosion Hot spot Inner core Lithosphere Mantle Mid-Ocean ridge Mountain-building Outer core Pangaea	3.5.10.A	3.3.10.A1	

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					Plate boundaries Rift Rock cycle Seafloor spreading Subduction zone Topography Transform Volcano Watershed			
	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Plate tectonics is the unifying theory that explains the geologic movements of the Earth.	Incorporate a variety of data including geological evidence from maps and representations of current plate motions to predict future plate motions.	Crust Mantle Convection Convergent Divergent Transform Sea-floor spreading Mid-ocean ridge Mountain-building	3.5.10.A	3.3.12.A1 3.3.10.A1 3.3.12.A3	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.	Use a model for Earth's interior including the mechanisms of thermal convection to support the explanation for the cycling of matter within the Earth.	Crust Cycling of matter Geochemical cycle Isotopes Mantle Plate Tectonics Radioactive decay Thermal convection	3.5.12.A	3.3.12.A1 3.3.12.A3	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	In addition to studying the early rock record, scientists can also learn about early Earth by studying objects in the solar system such as lunar rocks, asteroids, comets, and meteorites, which have changed little over time.	Construct an account of Earth's formation and early history (e.g. – origin of oceanic and atmospheric components) from evidence acquired from the study of ancient Earth materials and objects in our solar system.	Asteroid Comet Geology Meteorite Volcanic activity	3.5.10.A	3.3.12.A3	

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9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Continental rocks, which can be older than 4 billion years, are generally much older than rocks on the ocean floor, which are less than 200 million years old.	Construct explanations using the theory of plate tectonics for patterns in the general trends of the ages of both continental and oceanic crust.	Basalt Continental crust Granite Igneous Mantle Metamorphic Mid-ocean ridge Mountain-building Oceanic crust Paleo-magnetism Plate tectonics Rock cycle Sea-floor spreading Sedimentary Subduction	3.5.10.A	3.3.12.A1 3.3.10.A1 3.3.12.A3	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Our model of Earth includes a hot but solid inner core, a liquid outer core, a plastic mantle, and a solid crust.	Integrate evidence from seismic waves, reconstructions of Earth's magnetic field and states of matter to map the boundaries of the internal structure of the Earth.	Crust Inner core Liquid Magnetic field Mantle Outer core Plasticity Seismic waves Solid	3.5.10.A	3.3.12.A1 3.3.10.A1 3.3.12.A3	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and its organisms.	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on earth.	Atmosphere Biosphere Fossil Geosphere Hydrosphere Lithosphere	3.1.10.A	3.3.10.A3	BIO.B.3.2.1
	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere,	How and why is Earth constantly changing?	Biogeochemical cycles provide Earth's interconnected systems with a flow of energy and cycling of matter.	Develop qualitative models to describe biogeochemical cycles among the hydrosphere, atmosphere, geosphere, and biosphere.	Atmosphere Biosphere Carbon cycle Chemical properties	3.1.10.A 3.1.12.A 3.5.10.C 3.5.10.D	3.3.10.A2 3.3.10.A3 3.3.10.A4 3.3.10.A5 3.3.12.A5	BIO.B.4.2.3

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	atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.				Geosphere Hydrosphere Nitrogen cycle Water (hydrologic) cycle Phosphorous cycle Photosynthesis Physical properties			
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Earth's climate depends on the sun's output of electromagnetic radiation, as well as that energy's reflection, absorption and re-radiation by various Earth systems and types of surfaces.	Use models of the flow of energy between the sun and Earth's atmosphere, ocean and land to support explanations of how Earth's radiative energy balance is affected by the absorption and retention of heat in Earth's atmosphere.	Absorption Atmosphere Biosphere Climate Electromagnetic radiation Equilibrium Geosphere Hydrosphere Radiation Re-radiation Reflection	3.5.12.C	3.3.12.A6	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.	How and why is Earth constantly changing?	Climate changes happen on various time scales (e.g. - sun's energy output, Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and/or human activities).	Use data to graphically represent and draw conclusions about the causes and effects of climate change over 10-100s years; 1,000s-10,000s years; and 100,000s-1,000,000s.	Climate change Global warming	3.5.10.C	3.3.12.A6	
9-12	The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and	How and why is Earth constantly changing?	Climate changes happen on various time scales (e.g. - sun's energy output, Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and/or human activities).	Use geoscience data and the results from global climate models to make evidence-based forecasts of climate change.	Climate change Climate models El Nino Global warming Greenhouse gases La Nina Meteorology	3.5.12.C	3.3.12.A.6	

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	spatial scales.							
9-12	The Earth's processes effect and are affected by human activities.	How do Earth's processes and human activities affect each other?	Resource availability has influenced the development of human society.	Evaluate the impact of the availability of renewable and nonrenewable resources on the development of a civilization.	Biofuels Civilization Nonrenewable Renewable Resources Society	3.5.10.B 3.8.10.A	3.3.12.A2	
9-12	The Earth's processes effect and are affected by human activities.	How do Earth's processes and human activities affect each other?	The extraction of resources and production of energy have benefits and risks.	Evaluate the impact on Earth's systems of using renewable and nonrenewable resources. .	Benefit Biogeochemical cycles Biome Biosphere Carrying capacity Community Consumption Cost Desertification Earth system Ecology Economical Ecosystem Environment Extinction Geopolitical Habitat Nonrenewable Pollution Population Renewable Risk Species Sustainability System Temperature	3.5.10.B 3.5.12.B	3.3.12.A2 3.3.10.A7 3.3.12.A7 4.1.10.B 4.1.12.B 4.1.10.C 4.1.12.C 4.3.10.A 4.3.12.A 4.3.10.B 4.3.12.B 4.5.10.A	Bio.B.4.1.1. Bio.B.4.2.3 Bio.B.4.2.4 Bio.B.4.2.5
9-12	The Earth's processes effect and are affected by human activities	How do Earth's processes and human activities affect each other?	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction	Investigate human environmental impacts, comparing the kinds of solutions that are feasible, and designing	Abiotic Biotic Conservation Evidence	3.8.10.A 3.8.10.B 3.8.10.C 3.8.12.A	4.1.10.A 4.1.12.A 4.5.10.D 4.1.10.E	Bio.B.4.1.2 Bio.B.4.2.2.

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			of other species.	and analyzing solutions that could reduce that impact (e.g. examples of human impacts can include water usage, such as the withdrawal of water from streams and aquifers or the construction of dams and levees; land usage such as urban development, agriculture or the removal of wetlands; and pollution such as of the air, water or land.	Extinction Human impact Hypothesis Land use Model Pollution Urban development Wetlands	3.8.12.B 3.8.12.C	4.2.10.B 4.2.12.B 4.5.12.A	
9-12	The Earth's processes effect and are affected by human activities.	How do Earth's processes and human activities affect each other?	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species.	Construct an argument from evidence for how increases in human population and consumption of natural resources impact Earth's systems. (Examples of evidence include appropriate databases on human populations and the rates of consumption of food and natural resources such as fresh water, minerals and energy. Examples of impacts may include changes to the appearance, composition and structure of Earth's systems as well as the rates at which they change.) NOTE: The consequences of increases in human populations and consumption of natural resources are *described* by science. Even though science does not decide upon the actions societies take, science	Biogeochemical cycles Carrying capacity Consumption Earth systems Equilibrium Hypothesis Model Natural resources Non-point source pollution Point source pollution Rate of consumption Risk management Scientific evidence	3.8.10.A 3.8.10.B 3.8.10.C 3.8.12.A 3.8.12.B 3.8.12.C	3.3.10.A7 3.3.12.A7 4.1.10.A 4.5.10.C 4.5.12.C	

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				can help predict the consequences of those actions.				
9-12	The Earth's processes effect and are affected by human activities.	How do Earth's processes and human activities affect each other?	Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste.	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	Best management practices Engineering design process Green infrastructure Mitigation Model Pollution Technology Recycling Sustainability Waste management	3.8.10.B 3.8.12.B 3.8.10.C 3.8.12.C	3.4.10.A3 3.4.12.A3 4.5.12.D 4.1.12.E 4.3.10.D 4.3.12.D	